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STRATA CONTROL INVESTIGATIONS IN THE SYDNEY COALFIELD

Quarterly Report March 31, 1983

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Cape Breton Coal Research Laboratory

JUNE 1983

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STRATA CONTROL INVESTIGATIONS IN THE SYDNEY COALFIELD

Quarterly Report March 31, 1983

by

Tim Aston* and Peter Cain*

SUMMARY

This report reviews the progress and results of strata control investigations in the Sydney Coalfield for the period January 1 to March 31, 1983. Its purpose is to present details and results of field investigations implemented within the coalfield, update progress on current research activities and identify areas for future research.

Topics are discussed with respect to the activities carried out at CBDC mines; namely, Lingan, No. 26 and Prince. Current involvement on the Donkin-Morien Development Project is also described.

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ENQUÊTES SUR LE CONTRÔLE DES COUCHES AU BASSIN HOUILLER DE SYDNEY

Rapport trimestriel du 31 mars 1983

par

Tim Aston* et Peter Cain*

RÉSUMÉ

Les auteurs du rapport passent en revue les progrès et les résultats des enquêtes sur le contrôle des couches effectuées au bassin houiller de Sydney lors de la période commençant le 1er janvier et se terminant le 31 mars 1983. Le but du rapport consiste à présenter les détails et les résultats des enquêtes faites au bassin houiller, la mise à jour des progrès des activités de recherche en cours et l'identification des régions de recherche future.

On discute des sujets en ce qui a trait aux activités accomplies aux mines CBDC, c'est-à-dire Lingan, no 26 et Prince. De plus, on décrit les activités en cours dans le projet de développement Donkin-Morien.

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INTRODUCTION

A Coal Research Laboratory was established in Sydney, Nova Scotia to service the needs of coal mining activity in the Atlantic provinces. An opportunity therefore exists to establish strata control investigations specifically designed to provide practical input to mine planning and operational procedures. Initially, the scope of work undertaken will be limited by shortfalls in personnel, facilities and equipment. However, as the shortcomings are redressed, it is hoped that over the next few years, in cooperation with the Cape Breton Development Corporation (CBDC), the strata control research facility will possess sufficient background data and expertise to initiate advanced and innovative machinery and mining techniques.

The task of data collection has only just begun and this report presents a continuation of the results obtained as well as an update on current research activities. Finally, it is hoped that the information presented within this report will be of use to fellow researchers and CBDC personnel involved in the operation and planning of activity in the Sydney Coalfield.

LINGAN MINE

Since the last quarterly report, CBCRL involvement at Lingan Colliery has been limited to the installation of one site in the 3W Coal Road and the presentation of a proposal to monitor the behaviour of three-piece yielding arches in the 7E Materials Level.

The installation of an instrument site in the 3W Coal Road has allowed a partial comparison of the behaviour of the two gateroads in the 3W District to be made. A full analysis will not be possible until cored boreholes have been drilled at both sites. Results obtained to date from both sites are presented and discussed.

Following this, the proposals for a limited determination of yielding arch behaviour in the 7E Materials Level are presented.

THE ASSESSMENT OF GATEROAD DEFORMATION PROCESSES

Since the last report the site installed in the 3W Materials Level has been monitored and a new site in the 3W Coal Road established. Installation details and preliminary results from the first site are given in the 1st quarterly report[1].

Installation details of the second site are presented below, along with results obtained and a comparison between Materials Level and Coal Road behaviour.

Installation Details

The following instrumentation was installed at the site:

Load Cells - One in each of the pack-side and rib-side cribs.

Strata Bolts - A full strata bolt array was deployed, slightly modified due to the location of production machinery.

The full layout is shown in Figure 1.

Results

Monitoring at the site was carried out by both CBDC and CBCRL personnel; the frequency of monitoring decreased as the faceline moved away.

Results are presented under the following headings:

1) Differential Strata Movement
2) Gateroad Profile Deformation
3) Support Loading

Differential Strata Movement

Differential strata movement in the roof and floor can be determined from Figure 2, which is summarized in Table 1. No bolts were installed in the coal rib.

Differential movement of the immediate floor (the upper 0.9 m) was noticed after 9 days, when it was 4 cms. and increased until after 35 days it was 12 cms. It did not increase beyond this value after 55 days, the last reading.

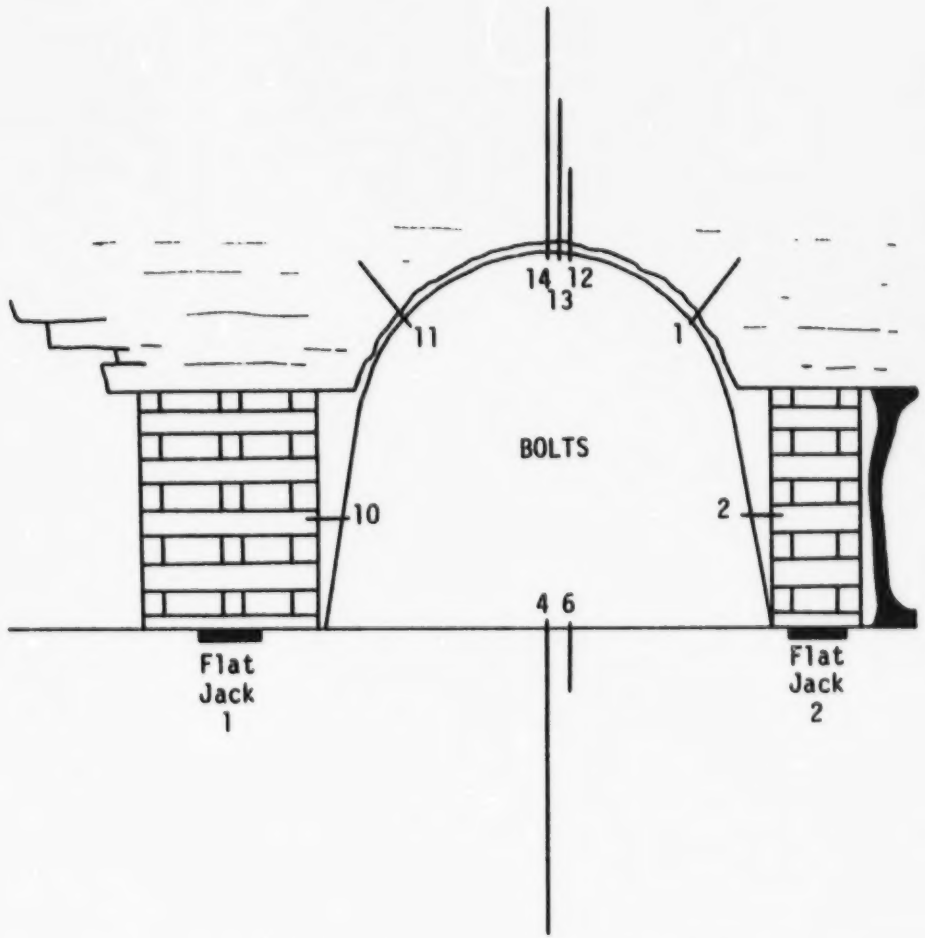


FIGURE 1 - INSTRUMENTATION LAYOUT IN THE 3W COAL ROAD, LINGAN COLLIERY

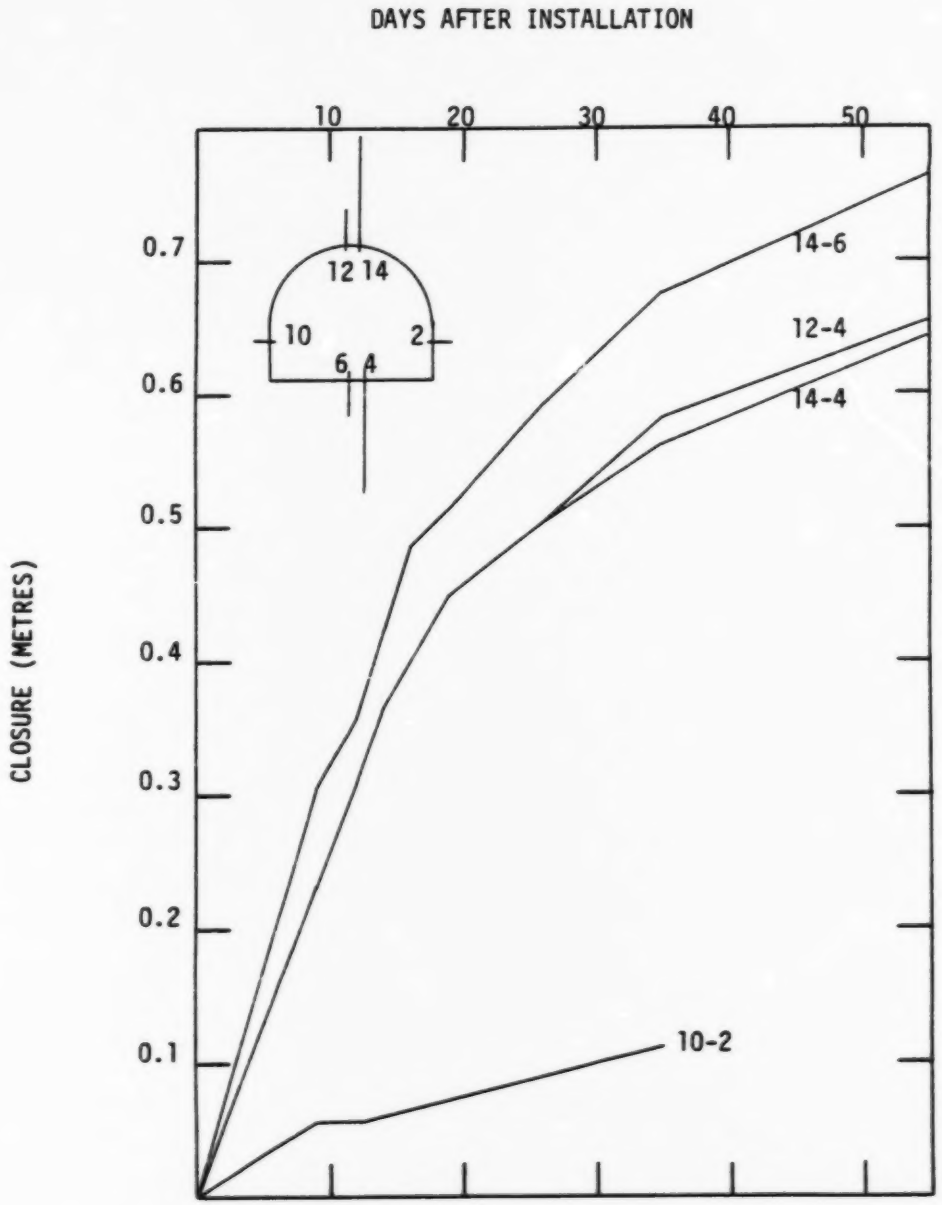


FIGURE 2 - DIFFERENTIAL STRATA MOVEMENT IN THE ROOF AND FLOOR OF THE 3W COAL ROAD

Table 1 - Summary of Differential Strata Movement In the 3W Coal Road After 35 Days

Separation Horizon	Total Movement
1.0-2.0 m above roof	0.018 m
2.0-2.5 m above roof	0.000 m
2.0-2.5 m below pavement	0.107 m

Table 2 - Summary of Strata Bolt Results in the 3W Coal Road After 35 Days

Bolt Pair	Total Closure
14-4	0.564 m
14-6	0.677 m
13-4	0.564 m
13-6	0.646 m
12-4	0.582 m
12-6	0.665 m
10-4	0.335 m
10-2	0.119 m
4-1	0.293 m
11-4	0.684 m

A small amount of differential movement of the roof strata was detected after 35 days, 2 cms., reducing to 1 cm. after 55 days.

Gateroad Profile Deformation

Strata bolt results are shown in Figure 3 and summarized in Table 2. The change in arch profile is shown in Figure 4.

Total vertical closure (between bolts 14 and 4) was 0.67 m. Lateral closure after 35 days was 0.11 m. Movement of the arch shoulders was not determined on a regular basis as measurement paths were often obstructed by machinery. However, readings do indicate approximately twice as much movement on the pack side as on the rib side (0.66 m compared to 0.27 m).

Support Loading

Pressure measurements were only obtained from the pack side crib. The pressure rose quickly to 2.4 MN. after 5 days, thereafter more slowly to 2.9 MN. after 40 days. This is illustrated in Figure 5. The rib side load cell was irreparably damaged shortly after installation.

Discussion

Results obtained so far indicate that the 3W Coal Road behaves in a similar manner to the 3W Material Level, except that the amounts of movement are much larger. The two sites do not allow direct comparison, however, as the Coal Road site was installed in the vicinity of a sandstone intrusion in the roof, the presence of which is often indicated at other locations by increased convergence.

The pattern of closure in the Coal Road exhibits two phases similar to Material Level closure. The duration of each phase and the convergence and rates of convergence are summarized below. Corresponding figures for the Materials Level are indicated in parentheses.*

*These may differ from the last report, as the results have been re-evaluated in the light of further data.

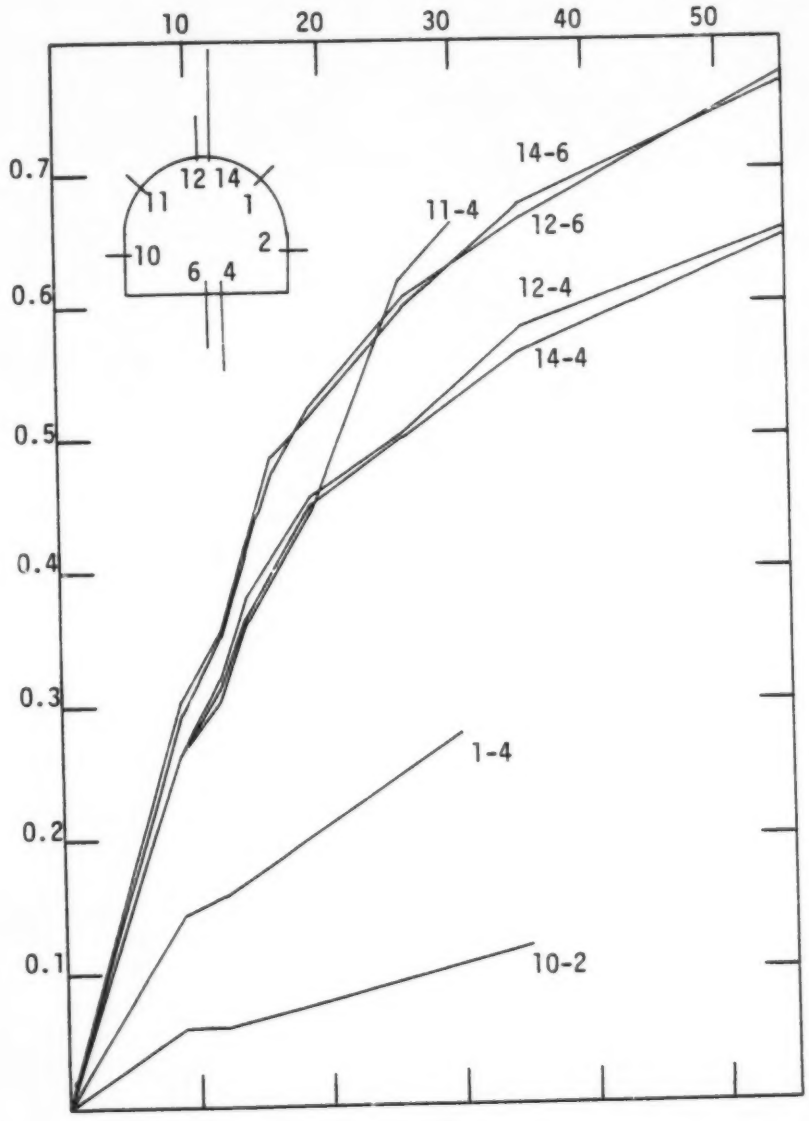


FIGURE 3 - STRATA BOLT RESULTS IN THE 3W COAL ROAD

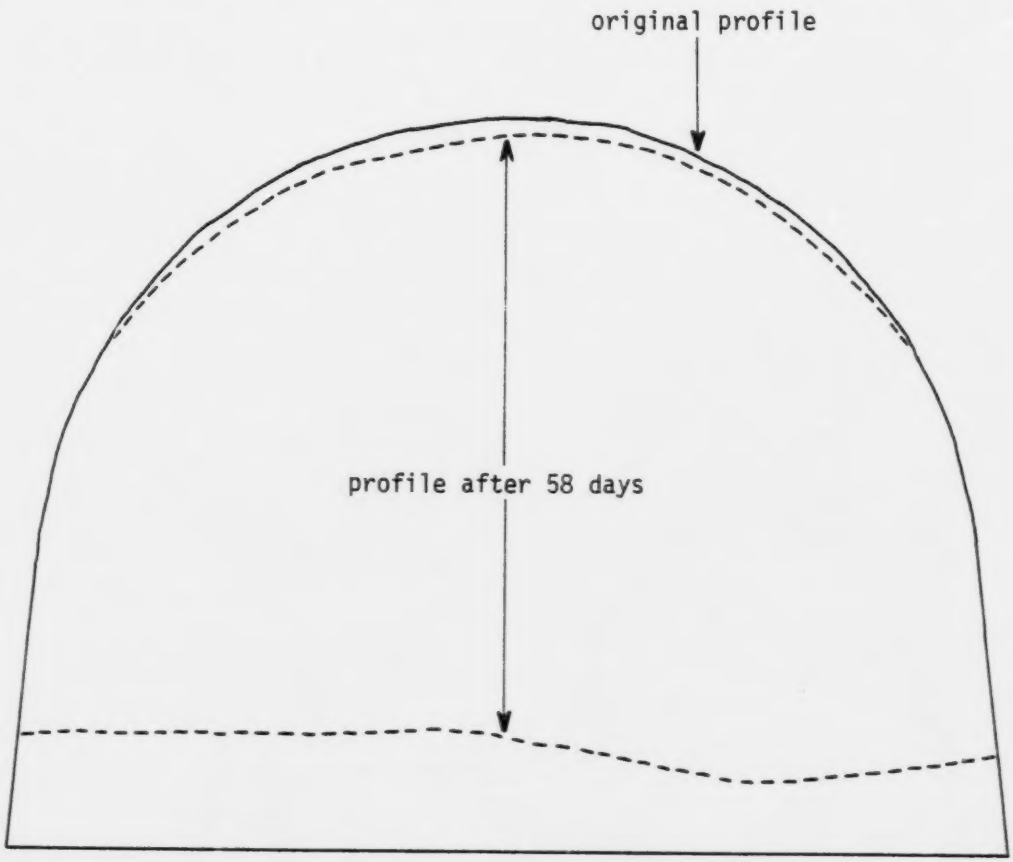


FIGURE 4 - ARCH PROFILE DEFORMATION IN THE 3W COAL ROAD

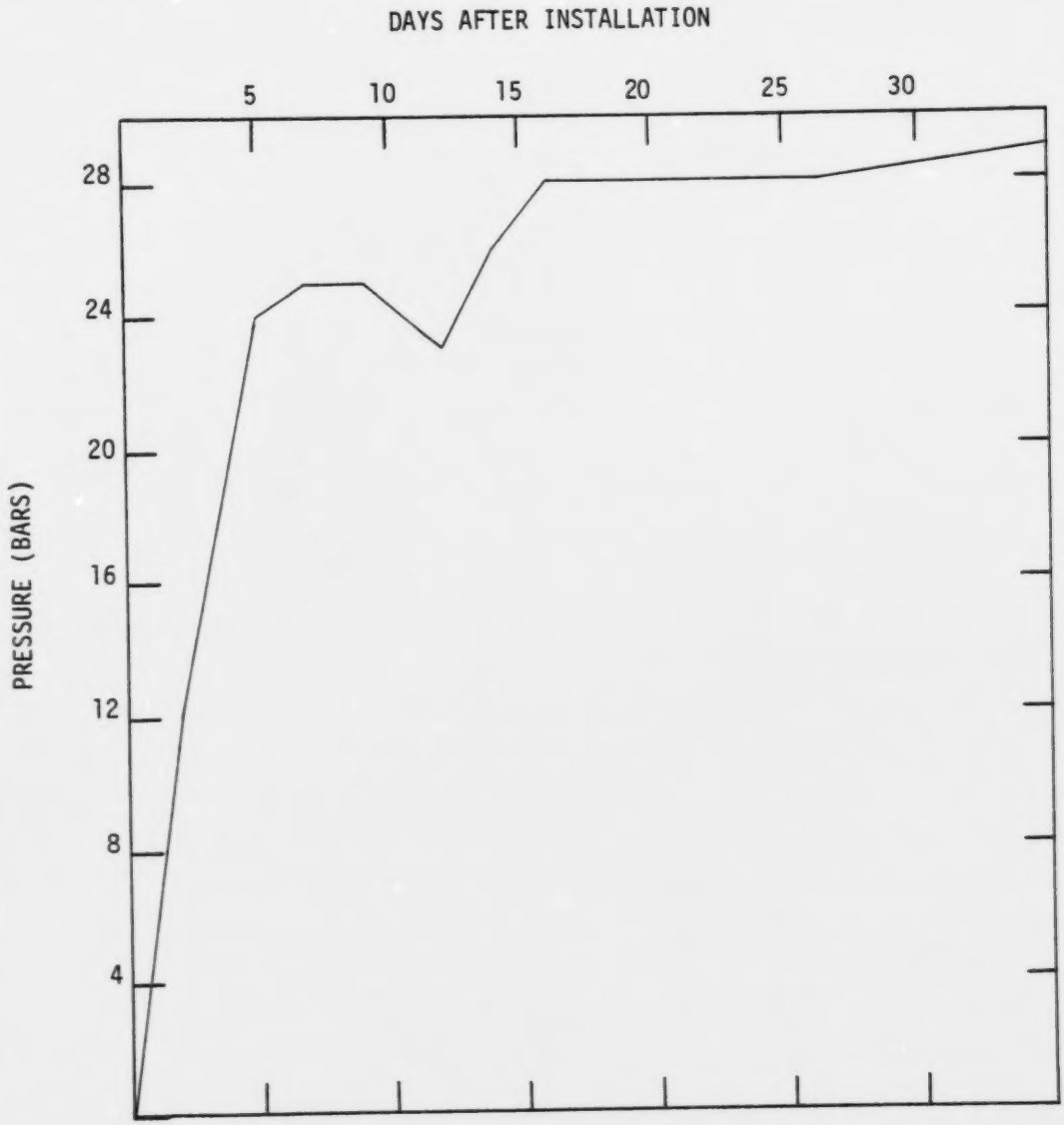


FIGURE 5 - PACK LOADING IN THE 3W COAL ROAD

Phase	Duration Days	Advance (m)	Vertical Closure bolts 14-4 m	Rate of Closure cm/day	cm/m advance
1.51 m/day	20	30.2	0.46	2.3	1.52
	(10)	(9.7)	(0.09)	0.9	0.92
0.96 m/day	35	33.83	0.185	0.028	0.546
		(193)	(0.19)	0.202	0.098

Another factor which might have affected deformation characteristics is the rate of face advance. This has not yet been fully assessed, but from the above figures daily advance averaged 1.51 m and 0.97 m in the Coal Road and Materials Level respectively. This is opposite to what would be expected, with slow face advances causing increased convergence.

Two factors would tend to increase the amount of floor heave:

1) the total amount of closure,
2) the presence of cribs on both pack and rib side.

Under the present conditions, it is impossible to determine which is responsible in the Coal Road.

Support loading results indicate that some floor penetration of the pack side crib might be occurring, although this was not monitored, nor was arch penetration.

Although the steel arches used in the Coal Road are of heavier section and slightly larger than in the Materials Road (3.65 m, 5.39 kg/m and 4.2 m, 8.29 kg/m respectively) these results seem to indicate some problems with floor heave. It is probably correct to say that under these conditions a single solid wood crib could replace the present hand stowed pack on the top level without too much difficulty, although further monitoring would be necessary to provide more positive answers.

Summary

The results indicate that Coal Road closure is greater than Materials Level closure, although geological and mining conditions make this comparison difficult to quantify.

The supports performed well without severe deformation, indicating that a similar method may be applicable to the Materials Level.

PROPOSAL FOR MONITORING THE YIELD CHARACTERISTICS OF THREE-PIECE YIELDING ARCHES IN THE 7E MATERIALS LEVEL, LINGAN COLLIERY

Introduction

The purpose of the investigation is to monitor the behaviour of three-piece yielding arches, and using the results obtained, to determine whether the clamping force is appropriate to the floor geology and whether the supports are more effective than standard arches in maintaining the cross sectional area.

The investigation is based on the monitoring of five parameters and general observations. The parameters are:

1) Distance from the faceline
2) Time since installation
3) Arch Yield
4) Floor penetration
5) Arch profile

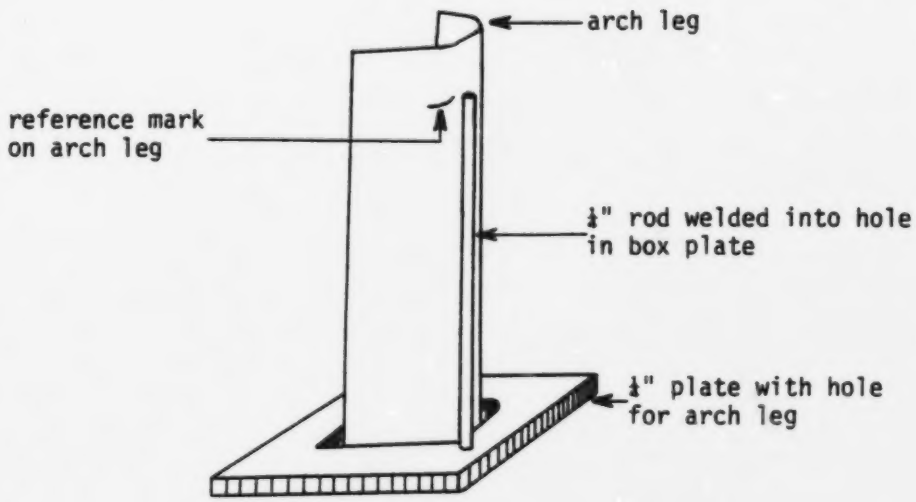
General observation of sideways buckling is also required.

Implementation

One arch per week should be set up for monitoring, e.g. the first arch installed on the Monday morning shift. Date, distance behind the face, clamping bolt torque, overbreak factors and lagging details should be recorded at installation.

The yield clamps must be marked at the time of installation. Future movement would be indicated as a separation of the marks on the arch.

In order to determine whether the arch clamping force was of the right magnitude, floor penetration of the arch must be monitored as well as the arch yield. This could be achieved either by measuring from a known point on the arch to the solid floor (which would require some excavation to locate) on the high and low sides of the arch at every reading, or by using the plate and rod mechanism proposed in Figure 6.



As arch leg penetrates the floor, penetration is measured between the reference mark and the top of the rod

FIGURE 6 - FLOOR PENETRATION INDICATOR

Arch profile should be recorded at intervals of two weeks, one month, two months, three months and thereafter quarterly. Profiles could be determined by tape and offset from a horizontal baseline or by photographic means.

Monitoring

Readings at each monitored arch would be taken at a frequency corresponding to the proximity of the faceline. Results would be recorded on data sheets and analyzed with regard to face advance and geological data. The deformation characteristics of the arch could then be determined and comparisons made between methods of installation and standard 'H' section arches. CBCRL would assist with the analysis if requested.

PRINCE MINE

Current work at Prince Mine involves testing floor strata from various locations in the mine.

This project is at an early stage in its development, and as yet, no results have been obtained. A brief background to it and a short description of the work being done is given.

FLOOR STRATA PROPERTIES TESTING

Prince Mine exhibits two quite different floor strata problems. The first is a weakening of the immediate sub-coal strata by weathering processes, resulting in penetration of the floor by the roadway supports leading to roof instability. The second is brittle fracture of the immediate sub-coal strata and heaving into the entry. The former problem is concentrated in long term roadways, for example the main access slopes, whilst the latter is a problem in the slope developments and also in the panel gateroads.

In order to assess these two problems, it is important to know the properties of the floor strata concerned, particularly:

1) their response to applied stress
2) their response to weathering

Accordingly, samples of floor material from several locations at Prince Mine were collected for testing. Bulk samples only were collected, as the core drilling planned for early 1983 had to be postponed due to delays in the delivery of a suitable core barrel.

Samples were collected from the 3W Materials Level at a floor heave location, and from two locations in the #3 slope, where the material was weathered.

The following properties will be determined from the samples obtained:

1) Triaxial strength properties
2) Uniaxial compressive strength
3) Youngs modulus and Poissons ratio
4) Tensile strength
5) Point load indices
6) Water content
7) Density
8) Consistency indices
9) Triaxial properties of the recompacted material
10) Moisture: Density relationships
11) Mineralogy
12) Susceptibility to weathering

By analyzing the results of these tests, it will be possible to design a complete test schedule for the core samples collected later in the year. This in turn will allow detailed consideration of the problems, leading to suggestions for their solution.

INSTRUMENTATION IN THE 3 EAST DISTRICT

At Prince Mine, a 'cundy' or crosscut connecting the gateroads of the 3E District, provided an opportunity to monitor the development of front and side abutment pressures ahead of the faceline. At relatively short notice CBCRL designed an instrumentation scheme for installation in the 'cundy' and adjoining junctions.

Essentially, the monitoring scheme consisted of pre-designated cribs instrumented with a load cell and four convergence stations, one at each corner. Unfortunately, due to unforeseen circumstances no meaningful readings were obtained. It is hoped to initiate a coordinated thrust to monitor support and strata behaviour in this region later in the year.

NO. 26 COLLIERY

Visits to the mine have been made by both authors and it is felt that two main areas have been identified which require the formulation of a cooperative research program with CBDC.

1) Floor heave problems in the 13 South Materials Road, its cause and the possible implementation of remedial measures. This aspect is considered particularly important since the proposed 14 South District may encounter similar conditions.
2) Outburst problems in areas overlain by sandstone channels.

THE DONKIN-MORIEN PROJECT

Work currently being undertaken at Donkin-Morien can be divided into two main sections:

1) Rock/Support Interaction Studies
2) Mine Water Studies

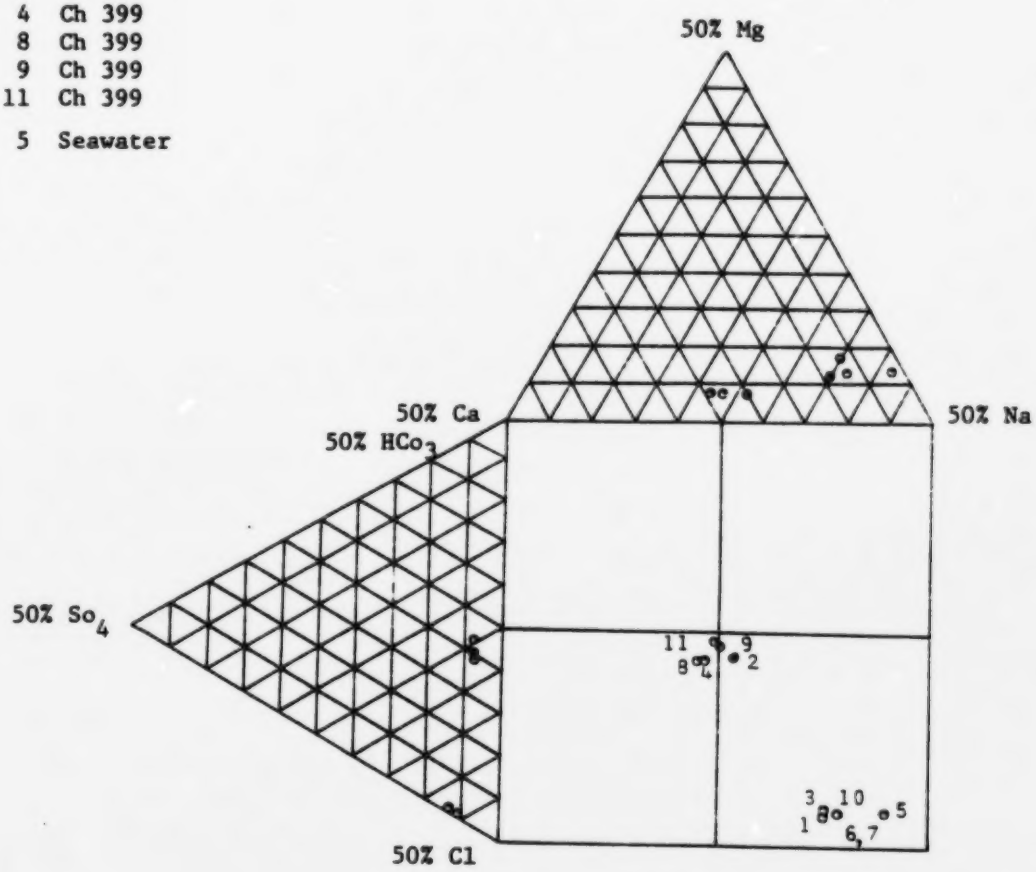
1) Rock/Support Interaction Studies

At the end of January 1983, the unsolicited proposal submitted by Golder Associates to monitor rock/support interaction in the access drivages was finalized. Currently the proposed re-structuring of the project is awaiting finalization by an external review committee. However, during the interim period it has been agreed that initial steps can be undertaken:

1) Purchase of the borehole periscope and certification of this unit.

Data Points

Nos.	
1	Ch 500
3	Ch 500
6	Ch 500
7	Ch 500
10	Ch 500
2	Ch 399
4	Ch 399
8	Ch 399
9	Ch 399
11	Ch 399
5	Seawater



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TITLE: Durov Diagram	drawn
No. 3 Tunnel, Donkin-Morien Project, November 26, 1982	checked
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2) Purchase of the drill and blast instrumentation (3 sites) and undertake its certification.

3) Undertake stress measurements in the massive sandstone unit from the drill and blast section of the No. 3 tunnel. The stress measurements will be undertaken in the manner shown in the original documentation, although the exact locations have still to be finalized.

2) Mine Water Studies

Minor water inflows have been experienced in several sections of the No. 3 tunnel. All available data concerning these inflows has been collected and is currently undergoing re-assessment. As part of the original program, between CBDC and Golder, hydrochemical analysis of the water was undertaken with respect to conductivity, pH and the concentration of sodium and chloride. In November 1982, through CBCRL involvement the hydrochemical program was expanded to enable alternative techniques to be employed in determining the origin of the inflow water, namely tri-linear plotting using Durov diagrams (2), (3).

Figure 7 shows a suite of samples collected in the No. 3 tunnel, 26th November 1982, plotted on a Durov diagram. Although two distinct types of water can be seen, the results represent multi-point sampling of individual 'feeders' at chainages 399 and 500. Comprehensive analysis of the data will be given in a report currently being prepared by CBCRL, CBDC and Golder personnel.

A limited program of water sampling has also been initiated to study a salt water intrusion currently being experienced in the Donkin fresh water well. Finally, all results obtained during both programmes will be included in a mine water data base being established for the Sydney Coalfield.

ACKNOWLEDGEMENT

The Cape Breton Coal Research Laboratory gratefully acknowledges the support and assistance of Cape Breton Development Corporation personnel in all

aspects of this work. In addition, thanks are due to Golder Associates and Beaver Construction Limited for their assistance in the work at the Donkin-Morien Project.

REFERENCES

1. Cain, P. and Aston T. "Strata Control Investigations in the Sydney Coalfield, December 1982"; Division Report ERP/CRL 82-16 (IR); CANMET, Energy, Mines and Resources Canada; 1982.

2. Chilinger, E.V. "Durov's Classification of Natural Waters and Chemical Composition of Atmospheric Precipitation in U.S.S.R.: A Review"; Trans. Am. Geophys. Union, Vol. 37, No. 2, April 1956, pp. 193-196.

3. Lawrence, A.R., Lloyd J.W. and Marsh, J.M. "Hydrochemistry and Groundwater Mixing in Part of the Lincolnshire Limestone Aquifer, England"; Groundwater, Vol. 14, No. 5, Sept-Oct 1976, pp. 320-327.